

INTEGRATED CIRCUIT FOR PLASMA DISPLAY PANEL DRIVERS

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1. FOREWORD

Electronic displays are now important to convey information visually and their technology is very interesting for advancing the information society. A plasma display is a discharge in a gas mainly composed of neon which emits an orange light. Since the display is easy to see, small in size, and light in weight, its wide use is expected in the future. Driving the display requires high-voltage, high-current ICs. For the purpose of increasing power, Fuji Electric has developed ICs by a Bi-CMOS process. In addition, a high voltage process has also been developed and has been applied to the production of ICs for DC and AC plasma display drivers and these devices have been put on the market. This paper describes the features and main characteristics of these ICs.

2. ICs FOR DC PLASMA DISPLAY DRIVERS

A plasma display driver is composed of ICs for scanning and driving anodes, and ICs for receiving and driving cathodes.

ICs for driving the cathode include a logic function and a high voltage output stage. These ICs are manufactured by a Bi-CMOS process. The logic function is composed of CMOS ICs and high voltage output stage npn bipolar transistors. ICs for driving the anode also include a logic function and a high voltage output stage. These ICs are manufactured by a D-MOS process. The logic function is composed of CMOS ICs and high voltage output stage p-channel FETs.

An overview is shown in *Fig. 1*. The figure shows a QFP-100 pin plastic package. This package has two types of leads, normal and reverse. Therefore it is easy to assemble to a board printed on only one side without crossing leads.

2.1 Cathode drivers

2.1.1 Circuit block

A circuit block of the ICs is shown in *Fig. 2*. These ICs include 68-bit shift registers and output transistors with open collectors. It is a main feature that these ICs

Fig. 1 Overview of ICs

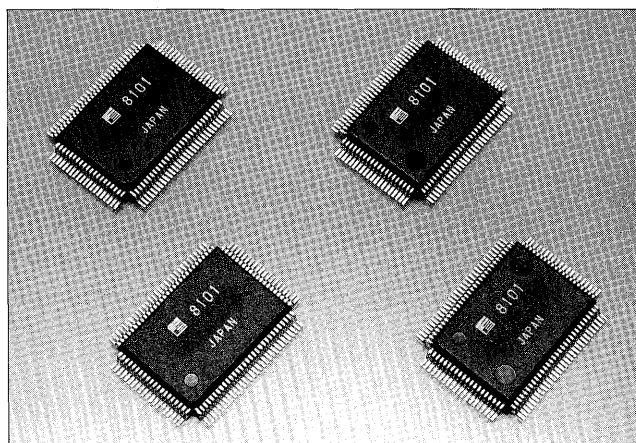
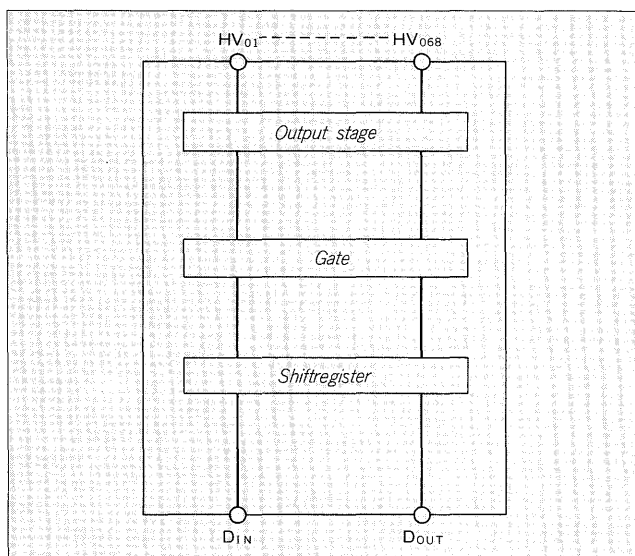


Fig. 2 Block diagram of ICs for driving cathode



have 68 output transistors, since only 6 ICs are needed for 408 dots in the plasma display and so it is easy to assemble. A photo of the chip is shown in *Fig. 3*.

2.1.2 Main characteristics

Scanning the display requires a large amount of power,

Fig. 3 Photo of ICs for driving cathode

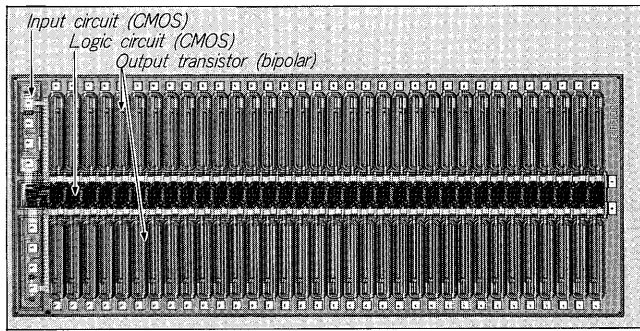


Fig. 4 Output characteristics of ICs for driving cathode

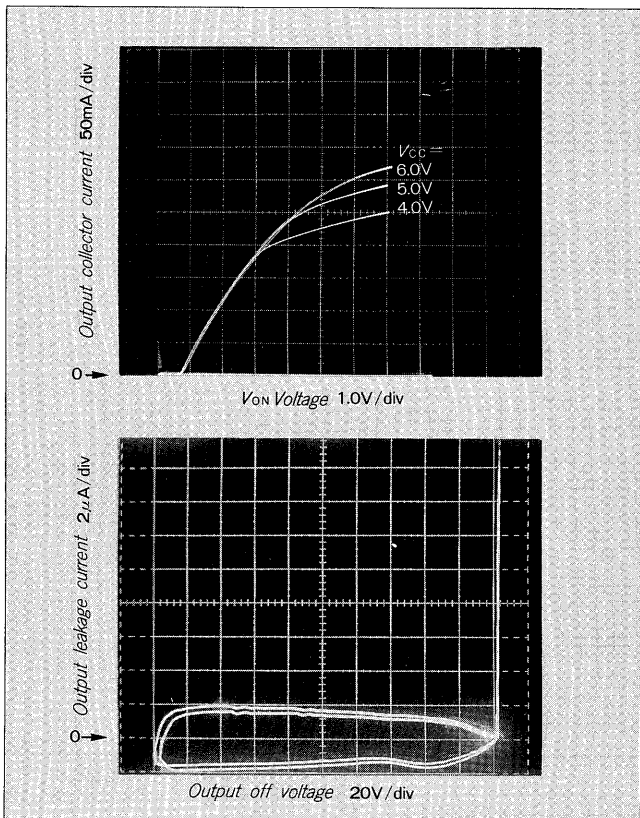


Table 1 Main characteristics of ICs for driving cathode

	Items	Typ.	Units	Remarks
Logic circuit	Supply current	1.0	mA	One output switches
	Input leakage current	1.0	μA	
	Input voltage	$V_{IH}=3.5$ $V_{IL}=1.5$	V	CMOS Level
	Delay time	0.3	μs	D_{OUT} , Time for CLK
Output transistor	Number of output	68	bit	
	Output voltage	125	V	Output off voltage =180V
	Saturation voltage	3	V	$I_{OL}=180mA$
	Saturation leakage current	1	μA	$HV=110V$
	Delay time	2.5	μs	t_d+t_t
	Power dissipation	1	W	
	Operating temperature	-20~+85	°C	

and since it is important for ICs to dissipate a small amount of power, the ICs are designed to have small collector resistance and to operate at practically the saturation voltage $V_{CE(sat)}$ which is under 5 volts with the collector current at 200mA. Further, the output voltage is over 180 volts. The output transistor has a driving transistor between its emitter and base. A photo of the output characteristics is shown in Fig. 4. Main characteristics are shown in Table 1.

2.2 Anode drivers

2.2.1 Circuit block

A circuit block of the ICs is shown in Fig. 5. These ICs include a 128-bit shift register, 32-bit unit $\times 4$, latch and output transistors with p-channel FETs. A photo of the chip is shown in Fig. 6.

These ICs have the function of multiple melodies.

2.2.2 Main characteristics

Logic function is composed of CMOS ICs and high voltage output stage D-MOS ICs. Since these ICs can operate at high speed and switch speedily at the output stage. The operating wave form of the output stage is shown in Fig. 7. This function is 4 melodies. Main characteristics is shown in Table 2.

Fig. 5 Block diagram of ICs for driving anode

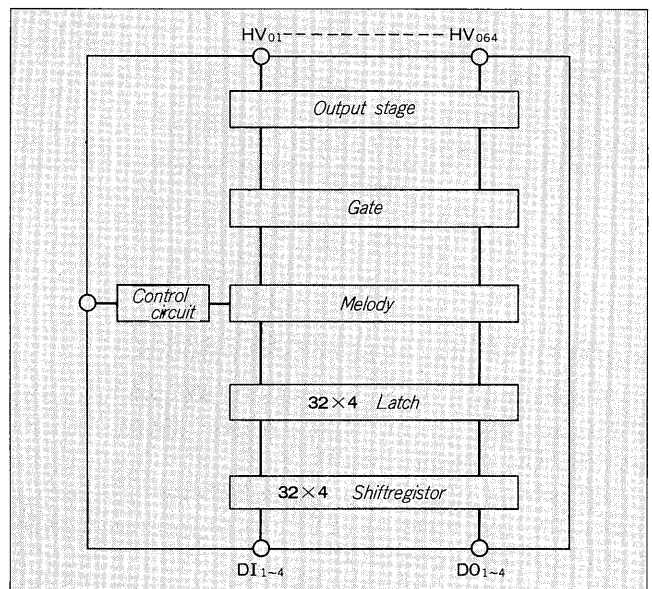


Fig. 6 Photo of ICs for driving anode

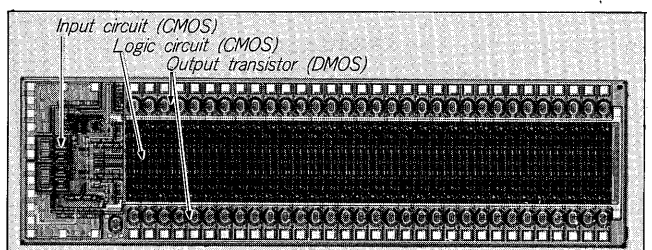


Fig. 7 Operating waveform of output stage

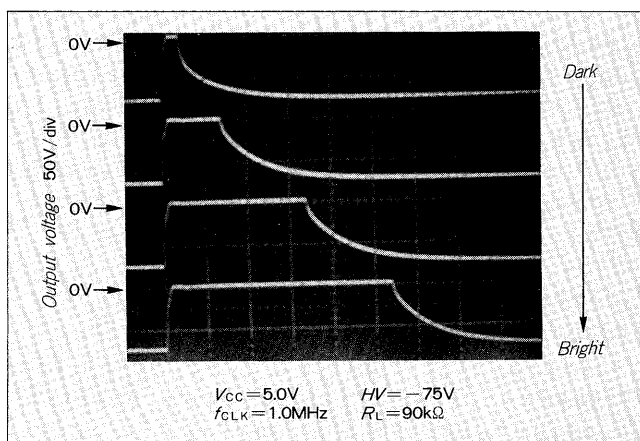


Table 2 Main characteristics of ICs for driving anode

Items		Typ.	Units	Remarks
Logic circuit	Supply current	3.0	mA	$f_{CLK}=5.5\text{MHz}$
	Input leakage current	1.0	μA	
	Input voltage	$V_{IH}=3.5$, $V_{IL}=1.5$	V	CMOS Level
	Frequency	5.5	MHz	
	Delay time	100	ns	D_{OUT} , Time for CLK
Output transistor	Number of output	64	bit	
	Output voltage	-120	V	
	Leakage current	1	μA	$HV=100\text{V}$
	Delay time	9.1	μs	t_d+t_t
	Power dissipation	1	W	
Operating temperature		-20~+85	$^{\circ}\text{C}$	

3. ICs FOR AC PLASMA DISPLAY DRIVERS

Fuji Electric has developed ICs for DC plasma display drivers and also for AC plasma display drivers. The ICs are now being mass produced.

AC plasma displays are said to be better for contrast, longer life, and easier to adapt for large panels as composed to DC plasma displays.

ICs have been developed that are used both for scanning and for receiving data. Logic function is composed of CMOS ICs and the high voltage output stage is composed of Bipolar and D-MOS ICs. The overview is the same as for Fig. 1. Similarly, a QFP-100 pin plastic package is also used and there are two types of leads, normal and reverse.

3.1 Circuit block

A circuit block diagram is shown in Fig. 8. These ICs include a shiftregister, latch, gate and output stage with push pull transistors (Ref Fig. 9). These ICs have 64-bit outputs.

Fig. 8 Block diagram of ICs for AC drivers

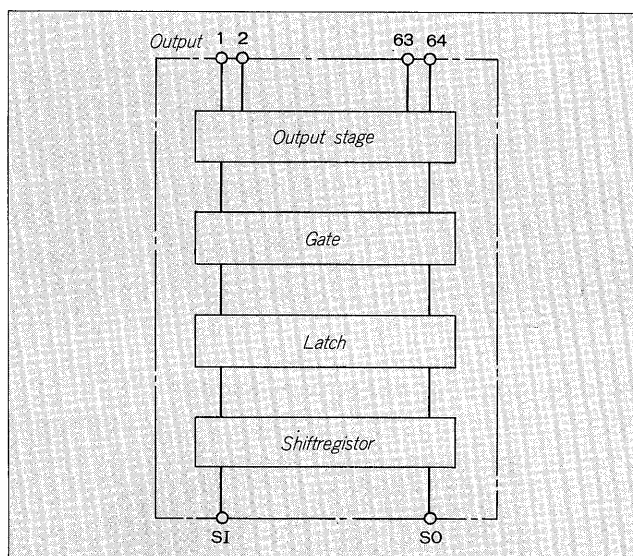


Fig. 9 Output stage of ICs for AC drivers

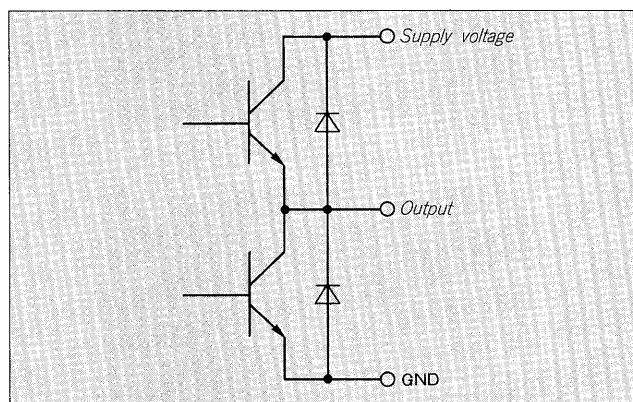


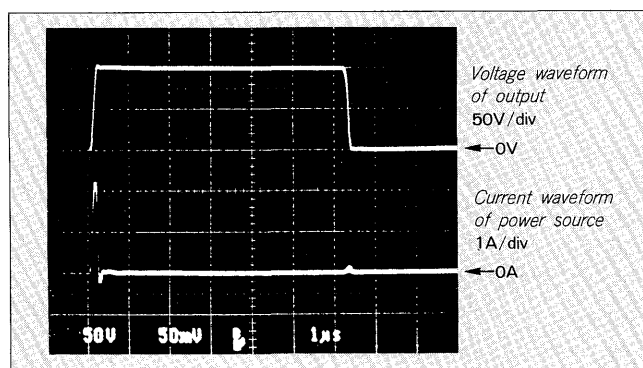
Table 3 Main characteristics of ICs for AC drivers

Items		Typ.	Units	Remarks
Logic circuit	Input leakage current	0.5	μA	
	Input voltage	$V_{IH}=3.5$, $V_{IL}=1.5$	V	CMOS Level
	Delay time	0.3	μs	D_{OUT}
Output transistor	Number of output	64	bit	
	Output voltage	155	V	
	Saturation voltage	± 7	V	$\pm 60\text{mA}$
	Leakage current	20	μA	$HV=155\text{V}$
	Delay time	0.3	μs	Time for STB
Power dissipation		2	W	25°C
Operating temperature		70	$^{\circ}\text{C}$	

3.2 Main characteristics

Main characteristics are shown in Table 3. Driving the display requires a large amount of power, and since it is important for ICs to dissipate a small amount of power.

Fig. 10 Operating waveform of output stage for AC drivers

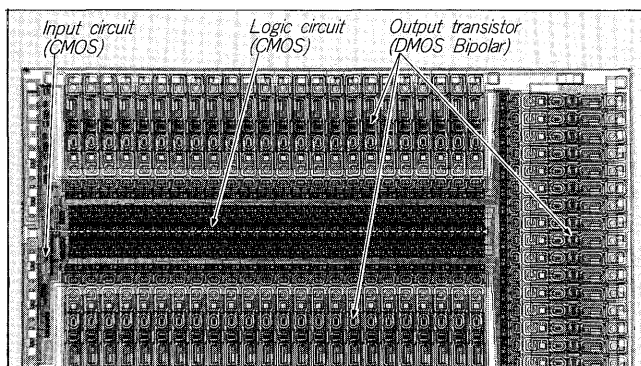


The saturation voltage of the output stage is designed to be low and at the same time to deliver high voltage which is designed to be over 155V. The dissipation of power by the switching output transistor is decreased because of high speed switching.

Output characteristics are shown in Fig. 10. The figure shows that rise time and fall time of output switching are each 100ns at a 30pF load. (Fig. 10 upper part). The current wave form of power source is shown in the lower part of Fig. 10.

The figure shows that the charging current for 30pF condenser flows at rising time and crossing current flows a

Fig. 11 Photo of ICs for AC drivers



little at falling time. A photo of ICs chip is shown in Fig. 11.

4. CONCLUSION

Fuji Electric has developed and produced a high voltage IC, and the main features and characteristics of it have been described in this paper.

In the future, plasma displays will require higher speed and performance for ICs in order to drive colored displays and larger displays. Fuji Electric will continue to develop new ICs to match the user's demands.